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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/469,709	12/21/1999	SHIJIAN LI	003786/PDD/C	5296

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APPLIED MATERIALS, INC.
2881 SCOTT BLVD. M/S 2061
SANTA CLARA, CA 95050

EXAMINER	
GOUDREAU, GEORGE A	

ART UNIT	PAPER NUMBER
1763	14

DATE MAILED: 02/25/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.	Applicant(s)
09-469709	Li et al
Examiner	**Group Art Unit**
George Goudreau	1763

—Th MAILING DATE of this communication appears on th cover sheet beneath the correspondence address—

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 (MONTH(S)) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, such period shall, by default, expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

☒ Responsive to communication(s) filed on 9-02 (ie, - papers #12-13)

☐ This action is **FINAL.**

☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle,* 1935 C.D. 1 1; 453 O.G. 213.

Disposition of Claims

☒ Claim(s) 30-44, 59-70 is/are pending in the application.

Of the above claim(s) _____ is/are withdrawn from consideration.

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) 30-44, 59-60, 65-70 is/are rejected.

☒ Claim(s) 61-64 is/are objected to.

☐ Claim(s) _____ are subject to restriction or election requirement

Application Papers

☐ The proposed drawing correction, filed on _____ is ☐ approved ☐ disapproved.

☐ The drawing(s) filed on _____ is/are objected to by the Examiner

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Pri rity under 35 U.S.C. § 119 (a)-(d)

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119 (a)-(d).

☐ All ☐ Some* ☐ None of the:

☐ Certified copies of the priority documents have been received.

☐ Certified copies of the priority documents have been received in Application No. _____ .

☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a))

*Certified copies not received: _____ .

Atta hment(s)

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). 13

☐ Interview Summary, PTO-413

☐ Notice of Reference(s) Cited, PTO-892

☐ Notice of Informal Pat nt Application, PTO-152

☐ Notic of Draftsperson's Patent Drawing Revi w, PTO-948

☐ Other _____

Office Action Summary

15. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

16. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103© and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

17. Claims 30-44, 59-60, and 65-70 are rejected under 35 U.S.C. 103(a) as being unpatentable over Avanzino et. al. (6,184,141) further in view of Chopra (6,276,996).

Avanzino et. al. disclose a two step process for cmp polishing a Cu layer (14) in a damascene down to a TaN barrier layer (12) which functions as a cmp polish stop. The first cmp polished steps is conducted with a polishing pad pressure of (4-7) psi with the wafer rotated at a speed of (60-150) rpm. This first cmp polish step is a rapid polish step which is used to remove (60-90) % of the bulk of the Cu layer. The second cmp polish step is conducted with a polishing pad pressure of (1-3) psi with the wafer rotated at a speed of 40 rpm. This second cmp polish step is a slow polish step which is used to remove the remaining (10-40) % of the Cu layer which

is on top of the TaN barrier layer. (They further teach that the rate of removal of the Cu layer during the cmp polishing process may generically be lowered by either decreasing the pressure applied to either the wafer or the cmp polishing pad or by decreasing the rate of rotation of the cmp polishing pad.) This is discussed specifically in columns 3-6; and discussed in general in columns 1-8. This is shown in figures 1-7. Avanzino et. al. fail to disclose the following aspects of applicant's claimed invention:

-the specific usage of an abrasive free cmp slurry in each cmp polishing step;

-the specific usage of a fixed abrasive linear belt to conduct each cmp polishing step;

-the specific usage of a computer readable medium to control the sequence of process steps;

-the specific rinsing of either the cmp polishing machine or each wafer after each cmp polishing step with a liquid which contains an anticorrosive agent;

-the specific cmp polishing of the TaN diffusion barrier layer on a third platen using a third cmp polishing step;

-the specific recycling of the cmp slurry used in each step; and

-the specific cmp polishing process parameters which are claimed by the applicant

Chopra teaches that it is desirable to cmp polish a Cu layer on a wafer using an abrasive free cmp slurry in combination with a fixed linear abrasive cmp polishing belt. Chopra further teaches that it is desirable to employ a cmp slurry comprised of an oxidant, an anticorrosive agent, H2O, a chelating agent, a surfactant, and a PH buffering agent which is used to adjust the cmp

slurry PH. This is discussed specifically in columns 2-5; and discussed in general in columns 1-8. This is shown in figure 1.

It would have been obvious to one skilled in the art to conduct the 2 step cmp polishing of the Cu layer on the wafer in the process taught above using a fixed abrasive linear belt in combination with the cmp slurry taught by Chopra based upon the following. First, this simply involves the usage of an alternative, and at least equivalent means for conducting the cmp polishing step taught above to those means which are specifically taught above. Second, Chopra teaches that their means for cmp polishing a Cu layer on a wafer is desirable. It would have been obvious to one skilled in the art to conduct the two step Cu cmp polishing step by rotating the fixed abrasive belt at a first speed during the cmp polishing step which is greater than that at which the fixed abrasive belt is rotated during a second cmp polishing step based upon the following. Avanzino et. al. teach that the Cu layer on their wafer may be conducted in two steps in which the first cmp polishing step cmp polishes the Cu at a greater rate than the second cmp polishing step. They further teach that the rate of cmp polishing the Cu layer on the wafer may be lowered by either decreasing the rotation rate of the polishing pad or by decreasing the pressure applied between the cmp polishing pad, and the wafer during the cmp polishing step.

It would have been desirable to cmp polishing the TaN layer on the wafer using a third cmp polishing step in a third cmp polishing machine based upon the following. The usage of a separate cmp polishing step to polish a diffusion barrier used in the formation of a Cu damascene during the planarization of the Cu layer used to fill the damascene is conventional or at least well

known in the cmp polishing arts. (The examiner takes official notice in this regard.) Further, it would have been desirable to use a separate cmp polishing step in a separate cmp polishing machine to cmp planarize the TaN diffusion barrier layer in order to maximize the through put of the process by using different cmp polishing machines to conduct each process step rather than conducting each process step sequentially in the same polishing machine using the same polishing platen. It would have been obvious to one skilled in the art to employ a fixed abrasive belt in combination with an abrasive free slurry to cmp polishing the TaN barrier layer in the process taught above based upon similar reasons to those stated above for the Cu layer.

It would have been obvious to one skilled in the art to rinse either the wafer or the cmp polishing pad after each polishing step with an anticorrosive agent based upon the following. The usage of rinse steps after a cmp polishing step to remove the cmp slurry from the wafer is conventional or at least well known in the cmp polishing arts. (The examiner takes official notice in this regard.) Further, it would have been desirable to rinse the wafer after each polishing step in order to prevent the undesirable cross contamination of the wafer with the different cmp slurries which are used in each step with each other. Further, the usage of an anticorrosive rinse step on a cmp polished wafer is conventional or at least well known in the cmp polishing arts. (The examiner takes official notice in this regard.) Further, it would have been desirable to prevent the undesirable corrosion of the Cu layer on the wafer by the acids in the cmp slurry following each cmp polishing step by treating the wafer with an anticorrosive agent which will protect the Cu from further corrosion after each cmp step.

It would have been obvious to one skilled in the art to recycle each of the cmp slurries used in the process taught above based upon the following. It would have been desirable to reduce operating costs by minimizing the amount of cmp slurry which is consumed during each process step by recycling it. Further, it would have been desirable to reduce the operating costs by minimizing the amount of spent cmp slurry which must be waste treated.

It would have been obvious to one skilled in the art to employ a computer readable medium to conduct the sequence of process steps taught above based upon the following. The usage of a computer readable medium to conduct a sequence of process steps in the semiconductor industry is conventional or at least well known in the semiconductor manufacturing arts. (The examiner takes official notice in this regard.) Further, it would have been desirable to reduce labor costs for conducting the sequence of process steps employed in the process taught above by automating the conduction of the sequence of process steps taught above through the usage of a computer readable medium.

It would have been prima facie obvious to employ any of a variety of different cmp polishing process parameters in the process taught above including those which are specifically claimed by the applicant. These are all well known variables in the cmp polishing art which are known to effect both the rate and quality of the cmp polishing process. Further, the selection of particular values for these variables would not necessitate any undo experimentation which would be indicative of a showing of unexpected results.

Alternatively, it would have been obvious to one skilled in the art to employ the specific process parameters which are claimed by the applicant in conducting the cmp polishing process taught above based upon In re Aller as cited below.

"Where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." In re Aller, 220 F. 2d 454, 105 USPQ 233, 235 (CCPA).

Further, all of the specific process parameters which are claimed by the applicant are results effective variables whose values are known to effect both the rate, and the quality of the cmp polishing process.

It would have been obvious to one skilled in the art to conduct the bulk copper cmp polishing step (i.e.-the first cmp polishing step) such that the Cu is removed at a rate greater than 5000 angstroms per minute in the process taught above in order to desirably increase the throughput of the process taught above by decreasing the total amount of time which it takes to process a single wafer.

18. Claims 30-44, 59-60, and 65-70 are rejected under 35 U.S.C. 103(a) as being unpatentable over the references as applied in paragraph 17 above further in view of the teachings of Seiichi et. al. (JP 11-040,526).

Seiichi et. al. teach that it is desirable to supply in-situ an anticorrosive fluid to a cmp polishing pad which is used to cmp polishing a Cu layer on a substrate after the cmp polishing step has been completed in order to reduce the amount of undesirable corrosion of the Cu layer

which occurs after each cmp step has been completely due to contact of the Cu layer with the cmp slurry after the cmp polishing step has been completed. This is discussed specifically in the abstract; and discussed in general in columns 1-8. This is shown in figures 1-4.

It would have been obvious to one skilled in the art to perform an in-situ rinse of the cmp abrasive belt used to cmp polish each layer in the process taught above after each cmp polishing step has been completed based upon the following. Seiichi et. al. teach that it is desirable to perform a an in-situ rinse of a polishing pad with a fluid containing an anticorrosive fluid after cmp polishing a Cu layer on a wafer using an anticorrosive fluid which desirably reduces the amount of corrosion of the surface of the Cu layer which occurs after the cmp polishing step has been completed.

19. Claims 61-64 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

20. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

21. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Examiner George A. Goudreau whose telephone number is (703) -308-1915. The examiner can normally be reached on Monday through Friday from 9:30 to 6:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Examiner Gregory Mills, can be reached on (703) -308-1633. The appropriate fax phone number for the organization where this application or proceeding is assigned is (703) -306-3186.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) -308-0661.

George A. Goudreau/gag

Primary Examiner

AU 1763